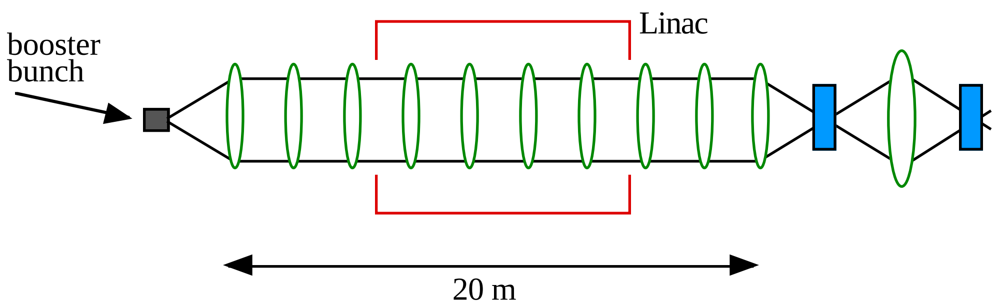
A Muon Beamline Option J. Norem 1/29/99

Basic elements

- Use a single booster bunch on target
- Keep the muons bunched at 805 MHz
- Try for simple, cheap, first stage

Components

- A conventional FODO lattice
  confines π's and decay μ's at similar momenta
  Yield ~ $p_{\mu}^{n}\, d\Omega/\beta^{n}$ - need TURTLE run
- 805 MHz linac
  maintains short booster bunch
- A final pion absorber using the large $\sigma_{\pi N}$ at $\Delta(1232)$
  scatters π's to produce μ beam



Issues:

- The RF is the most expensive component
- Additional shielding and magnetic analysis required
- Cooling experiments with bunches are different.
- Experimental program
  - Can look at earlier stages of cooling
  - Small $d\Omega dp$ can be increased for more μ's (solenoids)
  - Facility requirements - compatible with Boone ?
  - Challanges: measure, then cool, bunches
  - Better driver ⇒ better collection ⇒ real thing

A bunched muon beam at zero degrees from a booster bunch

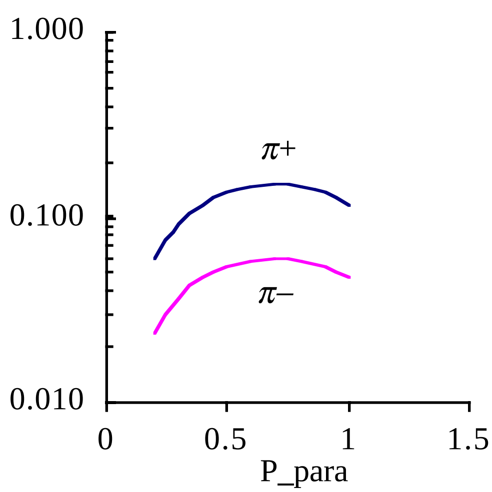
Basic Parameters

momentum =	0.43	GeV/c	=	0.313 MeV
pion mass =	0.139	GeV		
Momentum bite =	0.04	GeV/c		
	9.3	%		
beta =	0.95	pions		
gamma =	3.25			
pion lifetime =	2.60E-08	s		
muon mass =	0.106	GeV/c		
final muon momentum =	0.200	GeV/c	=	0.121 MeV

Pion yield

Booster protons =	4.E+12	protons/pulse	
bunches =	84		
protons =	4.8E+10	protons/bunch	
PPA numbers * 3		@3 GeV	
pi+ =	0.124	/proton-steradian-GeV/c	
pi- =	0.062	/proton-steradian-GeV/c	
Target =	2.5 cm Pt	*3	
Linac Aperture =	0.05	m	(Diameter)
linac distance =	1	m	
solid angle =	0.0025	Steradian	Li lens ? ? ?
pi+ =	5.9E+05	/pulse	
pi- =	2.9E+05	/pulse	

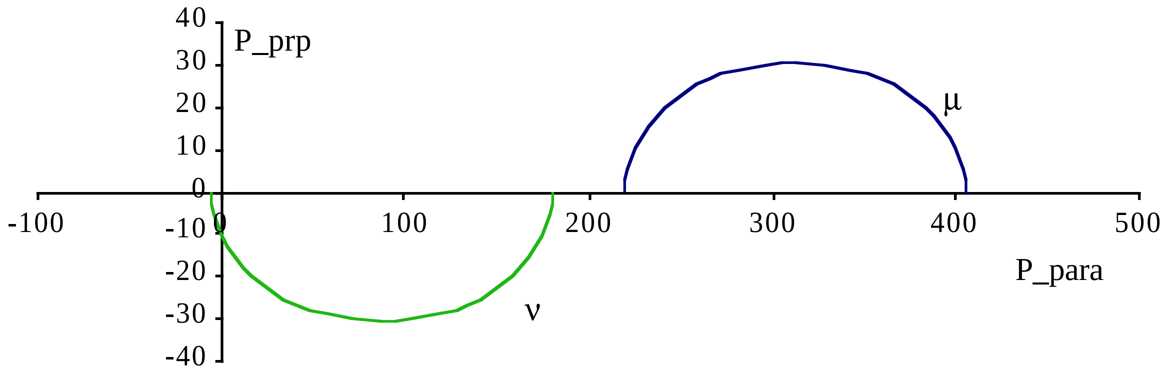
Production $d^2N/d\Omega dp$



Decays - these are estimates, need a turtle run to estimate the acceptance of FODO

decay length =	23.0	m
average beta function =	2.0	m
Beam Size =	0.10	m
Emittance =	0.0050	m rad
Maximum Decay angle =	0.087	rad
maximum emittance increase =	0.024	m rad
corr for accept of forwards =	2	
fraction of emittance =	0.41	in each plane for complete decays
length before decays =	2	m
pions entering decays =	0.92	
decay section length =	20	m
decay fraction =	0.58	
capured muons =	0.53	/pion
muons produced =	235088	
Longitudinally captured =	0.25	
final flux of muons =	9831	/pulse

Decay kinematics



Remove pions with Absorber at Delta(1232)

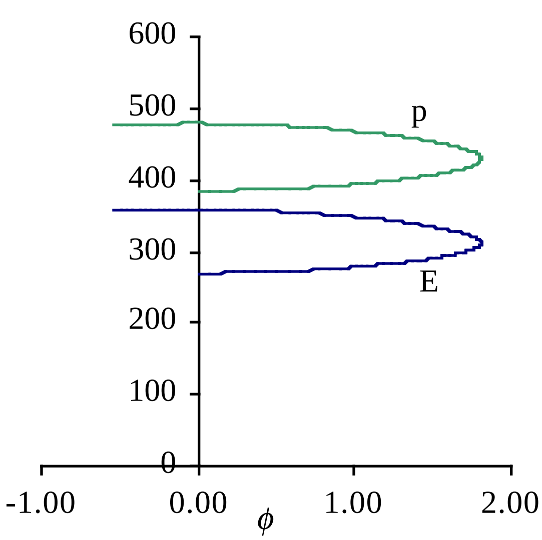
Effic of pion filter =	0.01			
material =	S	C	Be	
cross section =	1.7	0.7	0.5	Barns (from Mokhov)
density =	2.07	2.26	1.85	g/cm^3
dE/dx =	1.62	1.78	1.61	MeV/(g/cm^2)
Rad length =	21	42	65	g/cm^2
	10	19	35	cm
Int length =	27.2	28.3	29.6	g/cm^2
	13.1	12.5	16.0	cm
# ints req =	4.6	4.6	4.6	
Total length =	60.5	57.6	73.7	cm
Total E lost =	0.203	0.232	0.219	MeV
final p =	0.20	0.20	0.20	MeV/c
approx initial p =	0.42	0.45	0.43	MeV/c
Approx MS angle =	0.111	0.076	0.064	radians

Longitudinal Kinematics for the pion bunching linac (this page in MeV)

init E =	270	MeV
Design p =	430	MeV/c
grad =	3	MeV/m
dE/dx loss =	0	MeV/m
dZ =	0.4	m
x_init =	0.05	m
m_pi =	140	MeV
tau =	2.20E-06	sec
f_rf =	8.05E+08	Hz
A_max =	0.049	eV-sec
pion L_decay =	24	/m
decay =	41.74	%/10 m
Muon L_decay =	2703	/m
decay =	0.37	%/10 m
lambda_rf =	0.3727	m
beta av =	0.9509	
dL =	0.1073	m
dE =	0.3015	
A =	0.1017	m
Total E accel =	60	MeV
Bob's epsilon =	0.109	

The booster bunches are very short (perhaps $\sigma < 0.25$ ns), and most of this can be captured in one 805 MHz bucket. The time structure of a 430 MeV/c bunch can be maintained with even about 50 MeV of acceleration voltage if the cavities are placed halfway down the line. Half a synchrotron period takes about 30 m, which is the length of the line.

In synchrotron space



along the beamline